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CELESTITE FROM PERMIAN DEPOSITS OF THE SOUTHERN TIMAN

D. P. Serdyuchenko  
Presented by Acad D. S. Beiyankiny  
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During a 1941 survey of samples from bore hole No 1 at Bol'shiye Porogi in Vymkiy Rayon (Komi ASSR), among the rocks of the lower Permian anhydrolomite stratum at a depth of about 500 meters, I discovered celestite in the form of massive, coarse (3 to 4 mm) crystal aggregates inclosed in massive fine-grained light-gray dolomite.

The celestite is gray-blue or sky-blue in color. The mineral is transparent or semitransparent. The microscope indicates perfect cleavage along face 010 and less perfect cleavage along face 001. Since cleavage occurs at right angles, celestite can be split into elongated rectangular little blocks. Prismatic cleavage along face 110 is perfect and forms an orthorhombic system with the acute angle between cleavage cracks 110 and 110 equaling 75 degrees. This measurement in Fedorovskiy's table does not differ greatly from the goniometric measurement by which this angle (according to Dana) equals 75 degrees, 50 minutes for celestite.

$n_g$  equals  $1.630 \pm 0.002$ ;  $n_m$  equals  $1.624 \pm 0.002$ ;  $n_p$  equals  $1.621 \pm 0.002$ ;  $n_g - n_p$  equals 0.009;  $2V$  equals 49.5 degrees;  $\rho < \gamma$ . The plane of the optic axes is 010.

Extinction of the mineral with respect to the cleavage planes along 010 and 001 is parallel, but with respect to prismatic cleavage along 110 it is symmetrical. Specific gravity, determined by pycnometer at 20 degrees, equals 4.01.

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## Chemical Composition of Mineral

	<u>Percent</u>	<u>Molecular Part</u>
SiO <sub>2</sub>	0.64	---
MgO	0.30	0.008
CaO	1.12	0.020
SrO	53.76	0.519
BaO	0.42	0.003
SO <sub>3</sub>	<u>43.95</u> 100.19	0.548

Taking into consideration the sizes of the ionic radii (radiuses) Mg (0.78 Å), Ca (1.06 Å), Sr (1.27 Å), and Ba (1.43 Å) and also microscopic inclusions of dolomite in celestite crystals, we combine the total (determined by analysis) Mg with the corresponding amount of Ca in a molecule of dolomite.

Finally we obtain the composition of celestite: CaSO<sub>4</sub>-2.25, SrSO<sub>4</sub>-97.19, BaSO<sub>4</sub>-0.56, total 100.00 percent. This corresponds with the formula (Ca, Sr, Ba) SO<sub>4</sub>.

Paragenesis of celestite is established by its common occurrence and intimate association with dolomite, anhydrite, and gypsum.

Dolomite is massive light-gray rock shown under the microscope to consist of very fine (0.05-0.005) rhombohedral, or point, grains which impart pelitomorphic structure to the rock. In cross sections of celestite, especially those perpendicular to the prism, inclusions of dolomite are clearly visible. These are sometimes dispersed as single fine grains, and sometimes occur as fine-grained pelitomorphic spotty masses.

Anhydrite interstratifies with dolomite. It occurs in the form of strata, streaks, or lenticular bodies. The color of anhydrite is azure or azure-blue. The mineral has a glassy and vitreous transparency. Sometimes it has a saccharoidal or fine-grained structure. Under the microscope are seen very elongated prismatic fibers, which are curved, and either radiating or crisscrossing threads and strands with cleavage planes transverse to their lengths. Occasionally, masses of fine dolomite grains occur along the fibers. The microstructure of anhydrite rock is fibrous (nematoblastic).

Cleavage of the mineral is perfect along faces 010 and 001, less perfect along 100; extinction is parallel; 2V equals 41.5 degrees; 2V lies on face 010;  $\alpha_g$  equals 1.615;  $\alpha_p$  equals 1.572;  $\alpha_g - \alpha_p$  equals 0.043.

Specific gravity, determined by pycnometer at 20 degrees centigrade, varies within the limits 2.88-3.13 for different samples.

Gypsum occurs in the form of the comparatively coarse idiomorphic monoclinic crystals typical of this mineral, which are sometimes in the twinning position of the "dovetail" (lastochkin khvost) type. Gypsum monocrystals usually occur in small number in the immediate vicinity of dolomite, but develop partly at the expense of anhydrite fibers which they replace: 2V equals + 56 degrees;  $\alpha_g - \alpha_p$  equals 0.009;  $\alpha_g < 1.537$ ; 2V lies on face 010.

The genesis of celestite in the lower Permian deposits of Vymskiy Rayon is clearly connected with its precipitation by chemical means from highly con-

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centrated lagoon or residual salt-lake water, a fact which its entire mineral paragenesis indicates. In other similar deposits it is also common to find celestite associated not only with dolomite, anhydrite, and gypsum, but also with fluorite, halite, and sylvite.

Apparently, finely dispersed celestite crystals in the process of diagenesis and collective recrystallization originally formed comparatively coarse crystals and aggregates in pelitomorphic dolomite deposition.

The Vymskiy Rayon celestite deposit is connected with the post-Hercynian period of deposition and gravitates toward the extensive Permian celestite range which, according to L. V. Pustovalov, "is detected from the Northern region (Pinega River and Severnaya Dvina River basins) through the Tatar Republic up to the Kuybyshev region (middle Volga, vicinity of city of Kuybyshev, etc.) and enters into the Pre-Ural region (Bashkir ASSR, Chkalov Oblast) and even into the Urals (eastern Ural slope, vicinity of city of Kamensk); in all these places celestite is associated with gypsiferous rocks of the Artinskian, Kungurakian, or upper Permian age."

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